DRILLING AND MONITORING WELL INSTALLATION SPECIFICATIONS

PURPOSE

The purpose of the project is to install a small diameter monitoring well to a maximum depth of 150 feet which can be used for collection of water samples and measurement of ground water depths on an ongoing basis. The selection of equipment and materials and the procedures specified are intended to result in a monitoring well which can provide water samples representative of ambient ground water quality, unaffected by the drilling and well installation or well materials. All work will be supervised by the owner's representative.

EQUIPMENT

- The borehole is to be advanced with a top head drive air rotary drill rig equipped with a casing driver. The selection of bits is to be based on drilling conditions.
- The availability of a casing cutter is suggested. The casing will be removed from the hole and it may be necessary or desirable to cut off the drive shoe.
- A pump/mixer suitable for mixing and placing a bentonite slurry annular seal must be available. A tremie pipe/hose adequate to place the slurry to the bottom of the annular space will be used.
- An electric water level sounder suitable for measuring to the nearest test 0.10 feet will be made available by the driller at the drill site at all times.
- A weighted sounding device suitable for measuring depths to bottom of hole, top of gravel, top of seal, etc. to the nearest foot will be made available by the driller at the site at all times.

MATERIALS

- Casing - Six-inch minimum diameter steel casing meeting state standards will be advanced during drilling and pulled after the completion depth has been reached and monitoring well pipe installed.
- Monitoring well pipe - The monitoring well pipe shall be two-inch diameter schedule 80 flush threaded PVC such as that manufactured by Hydrophilic Industries, Inc., 5815 Meridian Avenue North, Puyallup, Washington, 98371, (206) 927-4321. The bottom five feet shall be blank pipe with a threaded PVC

plug. The next 50 feet or less shall be PVC screen with 3 rows of 0.020-inch milled slots. Unslotted riser pipe shall extend to approximately 1-1/2 to 2 feet above the ground surface.

- Gravel pack - Clean washed sand or gravel shall be placed in the annulus from the bottom of the borehole to approximately three to five feet above the top of the screen. Suitable material could range in grain size from #8 "traction" sand up to 1/4-inch minus "pea" gravel.

- Annular seal - The borehole annulus is to be sealed with bentonite. A minimum depth of three feet of bentonite pellets shall be placed immediately above the top of the gravel pack. The pelletized bentonite is to be equivalent to that available from Slope Indicator Company, 3668 Albion Place North, Seattle, Washington, 98103, (206) 633-3037. The annular seal from the top of the bentonite pellets to the ground surface shall be a bentonite slurry. The slurry shall consist of a high grade of granular or powdered bentonite mixed at a minimum ratio of approximately one (1) pound of bentonite per gallon of water.

- Security casing - A locking steel security casing at least five-inches in diameter with a minimum below ground depth of two feet shall be securely installed to protect the PVC monitoring well on completion of the well installation. The security casing shall be at least schedule 40 steel pipe. The lid shall be at least 1/4-inch thick steel plate. The configuration and construction of the security casing shall be as shown in the attached sketch, or as approved by the owner.

PROCEDURES

- Preparatory cleaning - Prior to drilling, the drill rig, drill rods including threads, casing, tools, and PVC well materials are to be thoroughly cleaned. All equipment will first be cleaned using an appropriate detergent/cleaning solution and then rinsed using clean steam/hot water. The steam cleaner/high pressure hot water washer will be provided by the owner at a site specified by the owner. Clean racks shall be provided by the contractor during drilling and well installation for stacking the downhole equipment.

- Drilling - A minimum six-inch diameter hole will be drilled to a maximum depth of 150 feet with steel casing being driven concurrently. Representative soil samples will be collected from cuttings at approximately five foot intervals for examination by the supervising geologist. Water samples will be collected from each water bearing zone or at approximately ten foot intervals once the water table is encountered. Water sample collection will be at the direction of the supervising

geologist and may require that drilling be stopped for periods of five to fifteen minutes for water to collect in the hole where saturated conditions occur in slowly permeable material.

No air injection additives, such as foam, will be used during drilling. The use of clean, potable water injected with the air will be considered on the basis of need and the potential effect on the completed monitoring well, and will be at the discretion of the supervising geologist. Tool and rod joint threads will not be lubricated with any petroleum base lubricant. The approved thread lubricant will be Ivory dish detergent and/or hand soap. Any other material to be used as a lubricant must be approved by the consultant prior to initial start up.

Upon completion of drilling and the installation of the monitoring well pipe it will be necessary to pull the casing. It will be the decision of the driller whether or not it is necessary to cut the casing shoe off prior to installing the PVC monitoring well. The casing must be pulled and cut without damage to the PVC. It is suggested that provisions be made to protect the top of the PVC from burning and/or melting while the casing is cut.

- Well installation - When the desired completion depth has been reached, the two-inch PVC monitoring well pipe and screen is to be installed in the borehole. The placement of the gravel pack adjacent to the screen will be alternated with the removal of the casing. The length of open hole between the bottom of the casing and the top of the gravel pack will be kept to a minimum and will be dictated in part by caving conditions of the formation.

  On completion of the gravel pack placement to a level of three to five feet above the top of the screen, a minimum of three feet of bentonite pellets are to be placed in the annular space. If above the water table, the pellets are to be wetted to initiate swelling. The remainder of the well annulus is to be sealed with bentonite slurry mixed at the previously specified ratio of water to bentonite. No other additives are to be added to the slurry seal material.

  Bentonite slurry should be added regularly and in quantities that will ensure that the level of the slurry in the hole is above the bottom of the casing at all times. The slurry will initially be placed through a tremie pipe or hose to within three to five feet above the top of the bentonite pellets. The tremie pipe or hose will be used whenever slurry must be placed below water. At the discretion of the supervising geologist the slurry seal may be subsequently "topped off" without the use of the tremie pipe or hose if conditions allow.

Subsequent to the removal of the casing the slurry seal will be brought to the ground surface and checked to ensure that settlement of the seal has stopped. The seal will be added to until significant settlement no longer occurs. A minimum period of 12 to 24 hours is to be allowed for slurry settlement prior to security casing installation.

The locking steel security casing will be placed over the PVC well pipe such that the security casing extends approximately two feet below the ground surface and the top is approximately one foot above the ground surface with the top of the PVC approximately one to three inches below the top of the steel security casing. The security casing will be securely concreted in place, see example drawing. At the discretion of the supervising geologist, it may be necessary to provide of checking the level and adding to the slurry seal after installation of the security casing. This may include the installation of a short section of pipe through the concrete adjacent to the security casing or a short section of pipe inside the security casing.

Upon completion of drilling and monitoring well installation, the driller will develop the two-inch monitoring well with air for a minimum of one hour or until the water discharged is essentially sediment free. The supplied air will be clean of all oils or other contaminants. An in-line air filter capable of removing oil must be used on any questionable air supply. The development will consist of at least alternately turning on and off the air supply, but may include surging and jetting as well.

The two-inch PVC pipe shall be free of bends, kinks, etc., such that a 1-3/4-inch diameter, 5 foot long cylinder may be lowered without binding to the bottom of the well. The drilling contractor shall be responsible for testing the well to meet this clearance specification.

- Personnel safety and protection - There are existing monitoring wells in the vicinity of the proposed well. Sampling of these wells has not detected the presence of any hazardous materials. However, because this is an industrial site, Level C body protection is required for conditions or materials which may be encountered, see below.

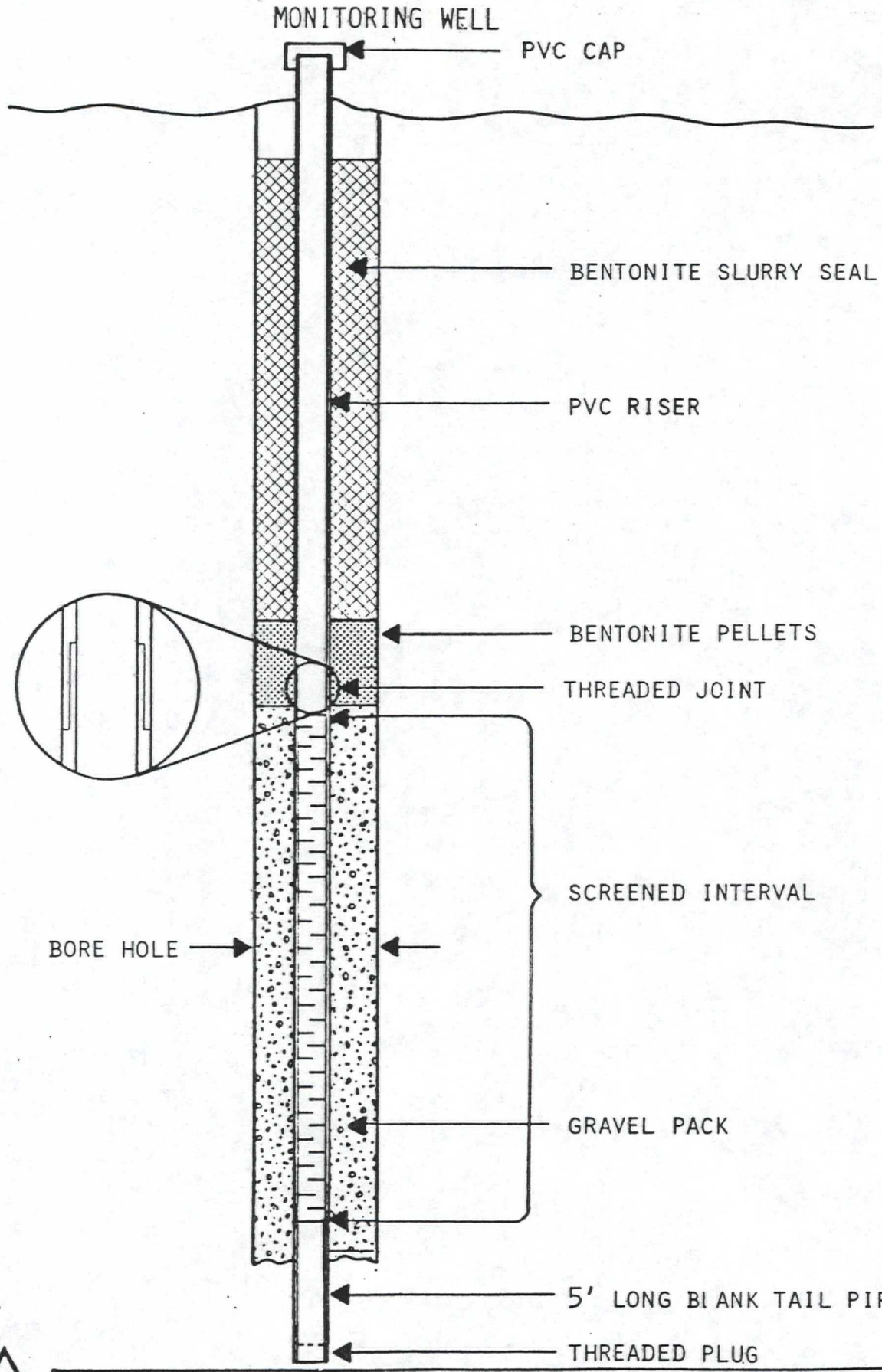
  Minimum Level C protection required to be used during all field operations:

  - Chemical resistant splash suit, one or two piece construction.

  - Chemical resistant gloves, safety boots, and hard hat.

Level C protection to be available for use if needed (these items are not anticipated to be needed):

- Face shield.
- Half or full face respirator with organic vapor cannisters.
- Oxygen/combustible gas meter for use near drill rig.



Sweet, Edwards & Associates, Inc. • P.O. Box 328 • Kelso, WA 98626

Revised Date
10/5/84

GENERAL DIAGRAM OF PIEZOMETER SECURITY CASING